2856

PATENTS

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Title:	Precise Measurement System For Barrier Materials	|		

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I, Stanley Z. Cole, hereby certify that this paper is being first class mail under CFR 1.08 with the U.S. Postal Service with proper postage affixed addressed to the Commissioner for Patents Alexandria, VA 22313 on June 2, 2003.

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Response to an Election Requirement

Honorable Commissioner of Patents:

This paper is intended to be responsive to the Election Requirement set forth in an Office Action restricting the pending claims to seven different categories. The Examiner is respectfully requested to reconsider the restrictions proposed in view of the following comments.

Concerning the restriction between I and III set forth in paragraph 3 on page 3, claim 1 measures transmission through a barrier material and claim 29 identifies a particular material. Note these are apparatus claims and the introductory phrase in the case of claim 29 does not define structure. Instead it sets forth the material the apparatus works on or a utility for the apparatus. Further concerning monitoring the integrity of the chambers and calibrating the mass spectrometer while the turbomolecular system is actuated, claim 1 includes a vacuum system in communication with the measurement chamber, it describes a vacuum for controlling flow of the gas into and out of

the test chamber and a controller for controlling the mass spectrometer , the vacuum system and the flow valve for sampling of the gas in the measurement chamber periodically. The pump is defined as a molecular pump in claim 2 and other claims dependent on claim 1. Since this is dynamic system it is reasonable to expect the controller of claim 1 to have computer or computer-like functions such as those designated in claim 19. It is respectfully submitted that the distinctions between the claims in group I and group III are the type of distinctions routinely found between claims in the same patent and it is therefore respectfully requested that the Examiner recognize that in fact these two groups can and should be appropriately grouped together for prosecution. See comments that follow suggesting that these groups be grouped with the other system and apparatus groups of claims.

The restriction as between I and V (paragraph 5 on page 4 of the Action) is stated to be on the basis that the subcombination (V) has a separate utility "such as a system for measuring transmission of a gas through a barrier material wherein a vacuum system is utilized to continuously draw a vacuum through a test chamber and a measurement chamber". It is submitted however, that if one compares this description with the wording of claim 1, it is seen that the apparatus of claim 1 comprises a system for measuring the transmission of a gas through a barrier material (so stated in the introduction of the claim), in which a vacuum system is used (see last two lines of the first indented segment[1]). Note also that there is described in claim 1 the use of a flow valve connected to a source of vacuum for controlling flow of said gas into and out of said test chamber (see the last three lines of the second indented segment) and a "vacuum system in valved communication with said measurement chamber (see third indented segment). Further, the use of a mass spectrometer in claim 1 and a residual gas analyzer in claim 46 is not a distinction in substance. A residual gas analyzer is a mass spectrometer with a limited measurement range (generally between 1 to 100 AMU, as compared to a mass spectrometer, which depending on use could read complex molecules up to several thousand AMU)[2] These

[1] References to claim segments are directed to the claims as they appear in the published version of the instant application.

[2] AMU is defined as 1/12 the mass of a carbon atom of mass 12.

comments would appear to clarify that in fact both of these groups, group I and V, have the same utility and overlapping components and thus should be grouped together.

The restriction as between group II and IV found in the paragraph marked 8 on page 4 of the Action is on the basis of combination and subcombination. In this instance the Examiner has stated that the subcombination (IV) has separate utility "such as a method for measuring the transmission of a selected gas through a barrier material, wherein the integrity of a rough vacuum is verified and the change in the partial pressure of the measurement chamber is measured over time and the change in the pressure is correlated to the permeability of the barrier material." If one considers the wording of claim 19, the single independent claim of group II, it is seen that it too provides for a method for measuring the diffusion of a gas through a barrier material (see the introductory portion of claim 19) and among other steps "continuously metering a set quantity of said gas into and out of said test gas chamber by controlling a rough vacuum to determine the concentration of ... gas in said test chamber (see "c)" in claim 19) and finally in "f)" of claim 19 using partial pressure readings to determine the transmission of the gas through the material being measured. It is the thus respectfully submitted that group II and IV have the overlapping utility as to group these two together.

In paragraph 9 on page 6 of the action the Examiner has distinguished between the groups of II and IV and the group of VI on the basis of a distinction between partial pressure found in the claims of groups II and IV and analyzing the concentration of the gas in the measurement chamber as set forth in claims 50-55 of group VI. It is respectfully submitted that the measurement displayed for a readout by a detector can be, by choice, partial pressure or concentration and that no separate measurement is required to obtain either of these quantities.

A basic sensor that may be used in this invention, for example, may be a mass spectrometer. The principals supporting the conclusion above that no separate measurement is required to read out either partial pressure or concentration will now be discussed using a mass spectrometer. The operating principal of a mass spectrometer is selectively detecting charged ions (molecules), which are deflected by magnetic or electric fields to achieve a distribution spatially dependent on

its mass. More accurately, it is the charge/mass ratio of the ions that determines the deflection distribution. In the present invention a mass spectrometer would function as a selective detector that counts (ionized) molecules. The mass spectrometer measures the number of molecules of various masses, in Atomic Mass Units (AMU), in units of partial pressure

Avogadro's Law states that equal volumes of all gases have the same number of molecules at the same temperature and pressure. Further, one gram-molecular weight, called a mole, of any gas has (approximately) 6.022×10^{23} molecules (particles)/mole, and occupies 2.241×10^4 cm^3/mole, at Standard temperature and pressure (273°K and 760 torr). Thus, the number of molecules, n, in a Standard cubic centimeter of any gas is given by

$$\frac{6.022 \times 10^{23} \text{ molecules (particles)/mole}}{2.241 \times 10^{4} \text{ cm}^3\text{/mole}} = 2.687 \times 10^{19} \text{ molecules/cm}^3$$

Dalton's law of partial pressures states that the pressure exerted by a mixture of gases is equal to the sum of the separate pressures, which each gas would exert if it occupied the volume alone. Further, the General Gas Law (Boyle's and Charles' Law) states the equivalence for different conditions: $P_1V_1/T_1 = P_2V_2/T_2$, where P_1, V_1, T_1 are for condition 1, and P_2, V_2, T_2 are for condition 2. Thus, the number of molecules per cubic centimeter for a gas at different pressures and say, $T_1 = T_2 = 273$°K, is given in Table 1.

Table 1

n = number of molecules/ cm^3	P = pressure in torr
2.687×10^{19}	760
3.535×10^{16}	1
3.535×10^{13}	.001
7.072×10^{12}	2×10^{-4}

Now consider, air as an example of mixed gases (assumed at Standard Conditions, 273°K and 760 torr, for simplicity). If the mass spectrometer detector of the present invention were used to measure air, the number of molecules/ cm^3 of each of the (main) individual gases in air would be determined, and the results are listed in column 2 of Table 2.

Table 2

Gas	n (molecules/cm^3)	PP (torr)	Concentration % (C by n)	Concentration % (C by PP)
N_2	2.097×10^{19}	593	78	78
O_2	5.622×10^{18}	159	21	21
Ar	2.510×10^{17}	7.1	0.93	0.93
CO_2	8.839×10^{14}	0.25	0.03	0.03
Ne	4.950×10^{14}	1.4×10^{-2}	0.0018	0.0018
He	1.414×10^{14}	4.0×10^{-3}	0.0005	0.0005
Kr	3.076×10^{13}	8.7×10^{-4}	0.0001	0.0001
H_2	1.414×10^{13}	4.0×10^{-4}	0.00005	0.00005

From this measurement and the Laws given above, the partial pressure (PP) of each gas in the mixture (air) also is known. Thus, the partial pressure of each gas (PP_{gas}) is given by

$$PP_{gas} = \frac{\text{measured number of molecules/cm}^3\text{ of that gas}}{\text{The number of molecules in a Standard cubic centimeter (for any gas)}} \times \text{Pressure}$$

For example the partial pressure of N_2 (PP_{N2}) is given by

$$PP_{N2} = \frac{2.097 \times 10^{19}\text{ molecules/cm}^3}{2.687 \times 10^{19}\text{ molecules/cm}^3} \times 760\text{ torr} = 593\text{ torr}$$

The values partial pressure values for each gas are listed in column 3 of Table 2.

Similarly, the concentration of each gas in the mixture (air) can be determined from the same mass spectrometer measurement of the number of molecules/cm^3 of that gas, for example, the concentration of gas (C_{gas}) is given by

$$C_{gas} = \frac{\text{measured number of molecules/cm}^3 \text{ of that gas}}{\text{The number of molecules in a Standard cubic centimeter (for any gas)}}$$

For example, the concentration of N_2 (C_{N2}) is given by

$$C_{N2} = \frac{2.097 \times 10^{19} \text{ molecules/cm}^3}{2.687 \times 10^{19} \text{ molecules/cm}^3} = 0.78 \text{ and in percent, x 100, = 78\%}$$

The percent concentration values (from n) of each gas are listed in column 4 of Table 2.

Of course, the concentration of each gas in the mixture also could be obtained from the ratio of its partial pressures to the total pressure:

$$C_{PP} = \frac{\text{partial pressures of the gas}}{\text{total pressure}}.$$ Thus, for N_2,

$$C_{N2} = \frac{593 \text{ torr}}{760 \text{ torr}} = 0.78 \text{ and in percent, x 100, = 78\%}$$

The percent concentration values, from the PP, of each gas are listed in column 5.

In practice, the pressure would not be 760 torr, and the measured number of molecules/cm^3 would be appropriately reduced as shown in Table 1. If the total pressure were 1 torr, the values would be 3.535×10^{16} instead of 2.687×10^{19}. If the total pressure sampled by the mass spectrometer measurement were 2×10^{-4} torr, the number of molecules in a cubic centimeter (for any gas)

would be 7.072×10^{12}. For the air example, the measured number of molecules/cm^3 of each of the (main) individual gases in air, listed in column 2 of Table 2, would be reduced by the scale factor, SF,

$$SF = \frac{7.072 \times 10^{12} \text{ molecules/cm}^3}{2.687 \times 10^{19} \text{ molecules/cm}^3} = 2.632 \times 10^{-7}.$$ For example, for N_2

$n = 2.097 \times 10^{19} \times 2.632 \times 10^{-7} = 5.519 \times 10^{12}$ molecules/cm^3,and the partial pressure of N_2 (PP_{N2}) would be $593 \times 2.632 \times 10^{-7} = 1.561 \times 10^{-4}$ torr. The concentrations would of course remain the same.

In summary, a mass spectrometer measurement can give the number of molecules/cm^3 of a gas, or of the individual gases in a mixture. The quantity (quantities) displayed for readout by an instrument can be, for example, partial pressure or concentration in chosen units. However, as shown above, no separate measurement of these readout quantities is made or required. Accordingly, it is respectfully submitted that groups VI should be grouped with groups II and IV.

In paragraph 10 on page 6 of the Action, the Examiner distinguishes the invention of group VII (claims 56-58) from the inventions of groups II, IV, and VI indicating that group VII has separate utility of measuring the transmission of a selected gas through a barrier material by correlating the transmission of helium through the barrier and to the gas of interest. A review however, of claims 53-55 will show that there is sufficient relationship between these groups to be grouped together.

Finally, the Examiner has in paragraph 12 at page 7, distinguished groups III and V stating that group V has a separate utility in describing a system for measuring transmission of a gas through a barrier material wherein a vacuum system is used to continuously draw a vacuum through the test chamber and the measurement chamber since the group III claims do not include all the limitations of the group V claims. It is respectfully submitted that the limitations of the group V claims are found in claim 29, the independent claim in group III, Specifically mentioned by the Examiner is measuring transmission of a gas through a barrier material. This is found in the

introductory section at the start of claim 29. In the second indented segment of claim 29 there is described a roughing pump in valved communication with the test chamber and with the measurement chamber as to suggest that similar limitations are found in these two groups. Accordingly, it is respectfully requested that the Examiner approve a grouping of the system or apparatus claims of groups I, III and V.

It is respectfully submitted that the Examiner should approve the grouping of all method claims, groups II, IV, VI and VII as an appropriate restricted single group. It is also respectfully submitted that the Examiner should approved the grouping of all system or apparatus claims, groups I, III and V, as a single group. If the Examiner agrees to this proposed grouping, Applicants select the group of II, IV, VI and VII, claims 19-28, 39-45 and 50-58, as their elected invention. If the Examiner does not agree to combine the groups as proposed, Applicants elect group II covering claims 19-28.

Respectfully submitted,

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